

CueStation Network Hub Communications Protocol and Hardware Reference Guide

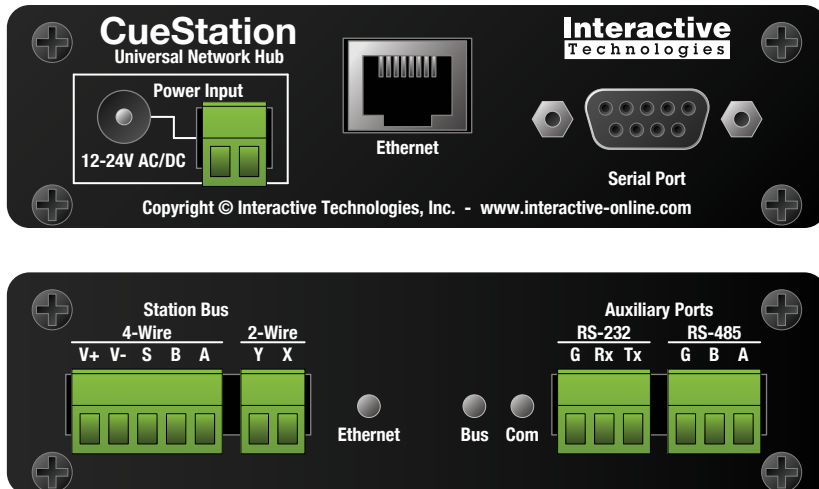
Introduction

The ST-HUB CueStation Universal Network Hub is used to both power and control an array of digital CueStations (both 2-Wire and 4-Wire types) using either an RS-232 protocol or an optional Ethernet protocol.

This document describes the communications protocol for the Hub's functions, which includes receiving button press, hold and release events from the stations as well as sending button indicator messages back to the stations.

You should use this document to understand the low-level protocol for communicating with the button stations, which is useful for integrating digital CueStations with 3rd Party systems or custom applications.

If you are integrating CueStation button stations with our CueServer DMX processors, there is no need (other than idle curiosity) to read this document, because CueServer automatically communicates with CueStations without the user needing to know the communications protocol.



Hardware

In addition to the main power supply input for the CueStation Hub, there are two host interfaces, two button station interfaces and two auxiliary ports available on the Hub. This section describes the use and configuration of each.

Power Supply

The CueStation Hub requires its own local power supply, from 12 to 24 volts, either AC or DC. The amount of current required can be calculated by using one of the following equations (the current is dependent on the number of CueStations connected to the Hub):

- In Watts: $4 \text{ Watts} + 0.6 \text{ Watts per 2-Wire Station} + 1.5 \text{ Watts per 4-Wire Station}$
- In Milliamps (12VDC): $333\text{mA} + 50\text{mA per 2-Wire Station} + 125\text{mA per 4-Wire Station}$
- In Milliamps (24VDC): $167\text{mA} + 25\text{mA per 2-Wire Station} + 63\text{mA per 4-Wire Station}$

There are two power input jacks on the Hub, a 2.1mm DC Input Jack and a 2-Position Terminal Block. You can use either one, but not both. If the 2.1mm DC Input Jack is used, it electrically disconnects the circuit from the Terminal Block input.

The standard power supply typically provided with the CueStation Hub outputs 1000mA at 12VDC, which is typically enough current to handle up to ten 2-Wire stations or five 4-Wire stations connected to the Hub.

RS-232

The CueStation Hub communicates with Host devices via RS-232 serial data. The Hub has two connections for RS-232 signals, a standard Female DB-9 serial port and a 3-Position Terminal Block for direct wiring. Either one of these ports may be used, but not both at the same time (the two ports are internally connected directly together and cannot accept signals from two different devices simultaneously).

The following diagram shows the pinout of the Female DB-9 as well as the corresponding position of the RS-232 Terminal Block:

Signal	DB-9 Pin	RS-232 Port Pin
Serial Tx (to external device)	2	Tx
Serial Rx (from external device)	3	Rx
Ground	5	G

The serial port uses the following parameters for communication with the Host:

Serial Parameter	Value
Baud Rate	38,400 bps
Data Bits	8
Parity	None
Stop Bits	1

When the Hub senses a button event on a station, it will send a string via it's serial port to the Host. When the Host wants to change the state of a station's indicator, the Host should send a string back to the Hub.

The strings sent and received on the serial port contain one or more CueStation messages, each of which look similar to "<BD0104>". This is an example of a message that means that Button 4 on Station 1 was pressed down. Complete details about CueStation messages are given in the "Protocol" section of this document.

Ethernet

If the Hub is outfitted with the optional Ethernet option (ST-HUB-EN), you can connect a standard CAT-5 type Ethernet cable to the Ethernet jack for communications with the Host device.

The Hub uses Multicast UDP packets to communicate to and from the Host. The parameters for Ethernet communications are below:

Ethernet Parameter	Value
Multicast Address	239.255.204.3
Port	52737
Protocol	UDP

When the Hub senses a button event on a station, it will broadcast a packet to the Multicast group (which will be received by the Host). When the Host wants to change the state of a station's indicator, the Host should broadcast a packet to the Multicast group (which will be received by the Hub).

The packets each contain one or more CueStation messages, each of which look similar to "<BD0104>". This is an example of a message that means that Button 4 on Station 1 was pressed down. Complete details about CueStation messages are given in the "Protocol" section of this document.

CueStation Bus

CueStations of both the 2-Wire and 4-Wire type can be connected to the Hub simultaneously. They are connected to the 2-Position and 5-Position Terminal Blocks available on the rear of the unit (the center pin of the 5-Position Terminal Block is for a cable shield, if present, which is not typically used).

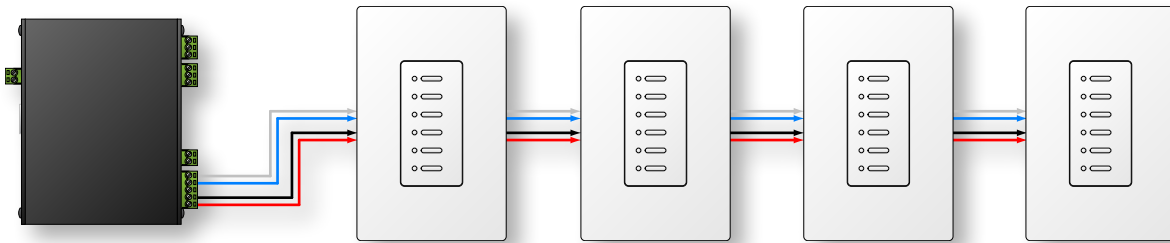
Each station has a station address, which is set by a group of dip switches on the back of each station. Each station must have a unique address. Please see the documentation for each station type to determine the appropriate dip switch settings.

4-Wire Station Bus Wiring

The 4-Wire CueStation Bus uses a 4-conductor 22/18 AWG Multi-Media Cable (Belden 1502 or similar). The network topology may be run in “daisy-chain” style **only** and all four conductors must be wired through without reversing polarity of the data lines.

A maximum of fifty (50) 4-Wire stations can be connected to a single CueStation Hub. The maximum distance from the Hub to the farthest 4-Wire Station is 4000 feet (1220m).

4-Wire Station Bus Wiring Example

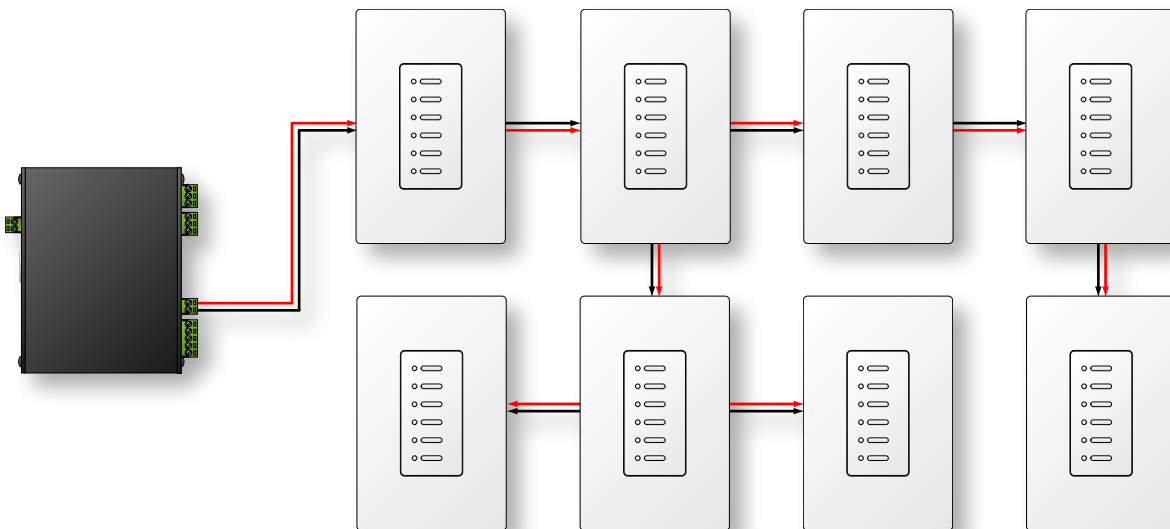


2-Wire Station Bus Wiring

The 2-Wire CueStation Bus uses a 2-conductor 18 AWG cable (Belden 9740 or similar) to carry both power and data to and from each station location. The network is both topology free (meaning a random combination of “star” and “daisy-chain” connections may be used) and polarity free (meaning it does not matter if the conductors are reversed at any station).

A maximum of ten (10) 2-Wire stations can be connected to a single CueStation Hub. The maximum distance from the Hub to the farthest 2-Wire Station is 500 feet (150m).

2-Wire Station Bus Wiring Example



RS-485 Port

The terminal block port marked “RS-485” is not used at this time. Do not connect anything to this port.

CueStation Messages

The messages passed between the CueStation Hub and the Host(s) are short ASCII-based strings. Each message begins with a less-than symbol (“<”). The next two characters are a message code. Then each message has several parameters that follows. After the parameters, the message ends with a greater-than symbol (“>”). The following illustration shows the basic structure of a CueStation message:

“<” + 2-Character Message Code + Parameters + “>”

The same message strings are used for both RS-232 communication as well as via UDP packets. When more than one message is needed, several messages can be strung together in a single packet or serial transmission.

The CueStation Hub ignores any characters received that are not enclosed in < angle-brackets >.

The following sections describe each message in detail.

Button Down Message

Message Format: <BD{station-number}{button-number}>

{station-number} = The station number, expressed in hexadecimal digits, from 01 to 32 (corresponding to stations 1 through 50).

{button-number} = The number of the button on the station, from 01 to 08.

Description: The Button Down message is sent by the Hub to any connected Hosts whenever the Hub detects that a button is pressed on a station.

Example: <BD0104>

The message above would be sent from the Hub whenever Button #4 was pressed down on Station #1.

Button Up Message

Message Format: <BU{station-number}{button-number}>

{station-number} = The station number, expressed in hexadecimal digits, from 01 to 32 (corresponding to stations 1 through 50).

{button-number} = The number of the button on the station, from 01 to 08.

Description: The Button Up message is sent by the Hub to any connected Hosts whenever the Hub detects that a button that had previously been pressed has now been released.

Example: <BU0307>

The message above would be sent from the Hub whenever Button #7 was released on Station #3.

Button Maintained Message

Message Format: <BM{station-number}{button-number}>

{station-number} = The station number, expressed in hexadecimal digits, from 01 to 32 (corresponding to stations 1 through 50).

{button-number} = The number of the button on the station, from 01 to 08.

Description: The Button Maintained message is sent by the Hub to any connected Hosts whenever the Hub detects that a button continues to be held down by the user for an extended period of time. After a button has been pressed and held down for one full second, a Button Maintained message is sent. The Button Maintained message continues to be sent once-a-second until the user releases the button. The Button Down and Button Up messages are always sent before and after a group of Button Maintained messages.

Example: <BM1C03>

The message above would be sent from the Hub whenever Button #3 was held down for more than one second on Station #28 (1C in hexadecimal).

Indicator Set Message

Message Format: <IS{indicator-value}{station-number}{indicator-number}>

{indicator-value} = The value to set the indicator to, expressed in hexadecimal digits, from 00 to FF. See the description below for details.

{station-number} = The station number, expressed in hexadecimal digits, from 01 to 32 (corresponding to stations 1 through 50).

{indicator-number} = The number of the indicator on the station, from 01 to 08.

Description: The Indicator Set message is from a Host to the Hub to set the value of an LED indicator on a station. The indicator's value determines its color, intensity and flashing pattern. Depending on model, some stations do not have the ability to remotely set the color of the LED indicator, in this case the color portion of the value is ignored. See the section below that describes LED Indicator Values for specifics on how to choose an indicator value.

Example: <ISFF0A02>

The message above would be sent from a Host to a Hub to set the value of LED indicator #2 on station #10 (0A in hexadecimal) to 255 (FF in hexadecimal).

Indicator Values

Each indicator on a station can be set to one of 8 different colors, with 4 intensity levels and 8 flashing patterns. These parameters are combined to provide 256 possible combinations, which can be expressed as a single 8-bit number.

The three parameters can be combined in a binary fashion to produce a value from 0 to 255 as expressed by the following chart. Add the values (in parenthesis) of each parameter together to calculate the desired indicator value. For example, the value 0 is "Off", the value 255 is "Full White", the value 139 is Fast Flashing Red at 75% brightness.

Bit Position	Bit Value	Function	Parameter
7	128	LED Intensity	00 (0) = Intensity 25% 01 (64) = Intensity 50% 10 (128) = Intensity 75% 11 (192) = Intensity 100%
6	64		
5	32	LED Color	000 (0) = Black 001 (8) = Red 010 (16) = Green 011 (24) = Blue 100 (32) = Yellow 101 (40) = Magenta 110 (48) = Cyan 111 (56) = White
4	16		
3	8		
2	4	LED Flash Pattern	000 (0) = Off 001 (1) = Slow Flash 010 (2) = Rev. Slow Flash 011 (3) = Fast Flash 100 (4) = Rev. Fast Flash 101 (5) = Wink 110 (6) = Rev. Wink 111 (7) = On
1	2		
0	1		

Alternatively, you can use the complete table on the next page that shows all possible combinations of LED indicator values.

Dec	Hex	Intensity	Color	Flash
0	00	25%	Black	Off
1	01	25%	Black	Slow
2	02	25%	Black	Rev. Slow
3	03	25%	Black	Fast
4	04	25%	Black	Rev. Fast
5	05	25%	Black	Wink
6	06	25%	Black	Rev. Wink
7	07	25%	Black	On
8	08	25%	Red	Off
9	09	25%	Red	Slow
10	0A	25%	Red	Rev. Slow
11	0B	25%	Red	Fast
12	0C	25%	Red	Rev. Fast
13	0D	25%	Red	Wink
14	0E	25%	Red	Rev. Wink
15	0F	25%	Red	On
16	10	25%	Green	Off
17	11	25%	Green	Slow
18	12	25%	Green	Rev. Slow
19	13	25%	Green	Fast
20	14	25%	Green	Rev. Fast
21	15	25%	Green	Wink
22	16	25%	Green	Rev. Wink
23	17	25%	Green	On
24	18	25%	Blue	Off
25	19	25%	Blue	Slow
26	1A	25%	Blue	Rev. Slow
27	1B	25%	Blue	Fast
28	1C	25%	Blue	Rev. Fast
29	1D	25%	Blue	Wink
30	1E	25%	Blue	Rev. Wink
31	1F	25%	Blue	On
32	20	25%	Yellow	Off
33	21	25%	Yellow	Slow
34	22	25%	Yellow	Rev. Slow
35	23	25%	Yellow	Fast
36	24	25%	Yellow	Rev. Fast
37	25	25%	Yellow	Wink
38	26	25%	Yellow	Rev. Wink
39	27	25%	Yellow	On
40	28	25%	Magenta	Off
41	29	25%	Magenta	Slow
42	2A	25%	Magenta	Rev. Slow
43	2B	25%	Magenta	Fast
44	2C	25%	Magenta	Rev. Fast
45	2D	25%	Magenta	Wink
46	2E	25%	Magenta	Rev. Wink
47	2F	25%	Magenta	On
48	30	25%	Cyan	Off
49	31	25%	Cyan	Slow
50	32	25%	Cyan	Rev. Slow
51	33	25%	Cyan	Fast
52	34	25%	Cyan	Rev. Fast
53	35	25%	Cyan	Wink
54	36	25%	Cyan	Rev. Wink
55	37	25%	Cyan	On
56	38	25%	White	Off
57	39	25%	White	Slow
58	3A	25%	White	Rev. Slow
59	3B	25%	White	Fast
60	3C	25%	White	Rev. Fast
61	3D	25%	White	Wink
62	3E	25%	White	Rev. Wink
63	3F	25%	White	On

Dec	Hex	Intensity	Color	Flash
64	40	50%	Black	Off
65	41	50%	Black	Slow
66	42	50%	Black	Rev. Slow
67	43	50%	Black	Fast
68	44	50%	Black	Rev. Fast
69	45	50%	Black	Wink
70	46	50%	Black	Rev. Wink
71	47	50%	Black	On
72	48	50%	Red	Off
73	49	50%	Red	Slow
74	4A	50%	Red	Rev. Slow
75	4B	50%	Red	Fast
76	4C	50%	Red	Rev. Fast
77	4D	50%	Red	Wink
78	4E	50%	Red	Rev. Wink
79	4F	50%	Red	On
80	50	50%	Green	Off
81	51	50%	Green	Slow
82	52	50%	Green	Rev. Slow
83	53	50%	Green	Fast
84	54	50%	Green	Rev. Fast
85	55	50%	Green	Wink
86	56	50%	Green	Rev. Wink
87	57	50%	Green	On
88	58	50%	Blue	Off
89	59	50%	Blue	Slow
90	5A	50%	Blue	Rev. Slow
91	5B	50%	Blue	Fast
92	5C	50%	Blue	Rev. Fast
93	5D	50%	Blue	Wink
94	5E	50%	Blue	Rev. Wink
95	5F	50%	Blue	On
96	60	50%	Yellow	Off
97	61	50%	Yellow	Slow
98	62	50%	Yellow	Rev. Slow
99	63	50%	Yellow	Fast
100	64	50%	Yellow	Rev. Fast
101	65	50%	Yellow	Wink
102	66	50%	Yellow	Rev. Wink
103	67	50%	Yellow	On
104	68	50%	Magenta	Off
105	69	50%	Magenta	Slow
106	6A	50%	Magenta	Rev. Slow
107	6B	50%	Magenta	Fast
108	6C	50%	Magenta	Rev. Fast
109	6D	50%	Magenta	Wink
110	6E	50%	Magenta	Rev. Wink
111	6F	50%	Magenta	On
112	70	50%	Cyan	Off
113	71	50%	Cyan	Slow
114	72	50%	Cyan	Rev. Slow
115	73	50%	Cyan	Fast
116	74	50%	Cyan	Rev. Fast
117	75	50%	Cyan	Wink
118	76	50%	Cyan	Rev. Wink
119	77	50%	Cyan	On
120	78	50%	White	Off
121	79	50%	White	Slow
122	7A	50%	White	Rev. Slow
123	7B	50%	White	Fast
124	7C	50%	White	Rev. Fast
125	7D	50%	White	Wink
126	7E	50%	White	Rev. Wink
127	7F	50%	White	On

Dec	Hex	Intensity	Color	Flash
128	80	75%	Black	Off
129	81	75%	Black	Slow
130	82	75%	Black	Rev. Slow
131	83	75%	Black	Fast
132	84	75%	Black	Rev. Fast
133	85	75%	Black	Wink
134	86	75%	Black	Rev. Wink
135	87	75%	Black	On
136	88	75%	Red	Off
137	89	75%	Red	Slow
138	8A	75%	Red	Rev. Slow
139	8B	75%	Red	Fast
140	8C	75%	Red	Rev. Fast
141	8D	75%	Red	Wink
142	8E	75%	Red	Rev. Wink
143	8F	75%	Red	On
144	90	75%	Green	Off
145	91	75%	Green	Slow
146	92	75%	Green	Rev. Slow
147	93	75%	Green	Fast
148	94	75%	Green	Rev. Fast
149	95	75%	Green	Wink
150	96	75%	Green	Rev. Wink
151	97	75%	Green	On
152	98	75%	Blue	Off
153	99	75%	Blue	Slow
154	9A	75%	Blue	Rev. Slow
155	9B	75%	Blue	Fast
156	9C	75%	Blue	Rev. Fast
157	9D	75%	Blue	Wink
158	9E	75%	Blue	Rev. Wink
159	9F	75%	Blue	On
160	A0	75%	Yellow	Off
161	A1	75%	Yellow	Slow
162	A2	75%	Yellow	Rev. Slow
163	A3	75%	Yellow	Fast
164	A4	75%	Yellow	Rev. Fast
165	A5	75%	Yellow	Wink
166	A6	75%	Yellow	Rev. Wink
167	A7	75%	Yellow	On
168	A8	75%	Magenta	Off
169	A9	75%	Magenta	Slow
170	AA	75%	Magenta	Rev. Slow
171	AB	75%	Magenta	Fast
172	AC	75%	Magenta	Rev. Fast
173	AD	75%	Magenta	Wink
174	AE	75%	Magenta	Rev. Wink
175	AF	75%	Magenta	On
176	B0	75%	Cyan	Off
177	B1	75%	Cyan	Slow
178	B2	75%	Cyan	Rev. Slow
179	B3	75%	Cyan	Fast
180	B4	75%	Cyan	Rev. Fast
181	B5	75%	Cyan	Wink
182	B6	75%	Cyan	Rev. Wink
183	B7	75%	Cyan	On
184	B8	75%	White	Off
185	B9	75%	White	Slow
186	BA	75%	White	Rev. Slow
187	BB	75%	White	Fast
188	BC	75%	White	Rev. Fast
189	BD	75%	White	Wink
190	BE	75%	White	Rev. Wink
191	BF	75%	White	On

Dec	Hex	Intensity	Color	Flash
192	C0	100%	Black	Off
193	C1	100%	Black	Slow
194	C2	100%	Black	Rev. Slow
195	C3	100%	Black	Fast
196	C4	100%	Black	Rev. Fast
197	C5	100%	Black	Wink
198	C6	100%	Black	Rev. Wink
199	C7	100%	Black	On
200	C8	100%	Red	Off
201	C9	100%	Red	Slow
202	CA	100%	Red	Rev. Slow
203	CB	100%	Red	Fast
204	CC	100%	Red	Rev. Fast
205	CD	100%	Red	Wink
206	CE	100%	Red	Rev. Wink
207	CF	100%	Red	On
208	D0	100%	Green	Off
209	D1	100%	Green	Slow
210	D2	100%	Green	Rev. Slow
211	D3	100%	Green	Fast
212	D4	100%	Green	Rev. Fast
213	D5	100%	Green	Wink
214	D6	100%	Green	Rev. Wink
215	D7	100%	Green	On
216	D8	100%	Blue	Off
217	D9	100%	Blue	Slow
218	DA	100%	Blue	Rev. Slow
219	DB	100%	Blue	Fast
220	DC	100%	Blue	Rev. Fast
221	DD	100%	Blue	Wink
222	DE	100%	Blue	Rev. Wink
223	DF	100%	Blue	On
224	E0	100%	Yellow	Off
225	E1	100%	Yellow	Slow
226	E2	100%	Yellow	Rev. Slow
227	E3	100%	Yellow	Fast
228	E4	100%	Yellow	Rev. Fast
229	E5	100%	Yellow	Wink
230	E6	100%	Yellow	Rev. Wink
231	E7	100%	Yellow	On
232	E8	100%	Magenta	Off
233	E9	100%	Magenta	Slow
234	EA	100%	Magenta	Rev. Slow
235	EB	100%	Magenta	Fast
236	EC	100%	Magenta	Rev. Fast
237	ED	100%	Magenta	Wink
238	EE	100%	Magenta	Rev. Wink
239	EF	100%	Magenta	On
240	F0	100%	Cyan	Off
241	F1	100%	Cyan	Slow
242	F2	100%	Cyan	Rev. Slow
243	F3	100%	Cyan	Fast
244	F4	100%	Cyan	Rev. Fast
245	F5	100%	Cyan	Wink
246	F6	100%	Cyan	Rev. Wink
247	F7	100%	Cyan	On
248	F8	100%	White	Off
249	F9	100%	White	Slow
250	FA	100%	White	Rev. Slow
251	FB	100%	White	Fast
252	FC	100%	White	Rev. Fast
253	FD	100%	White	Wink
254	FE	100%	White	Rev. Wink
255	FF	100%	White	On